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(54) REFRACTORY POURING NOZZLES

(71) We, STOECKER & KUNZ G.m.b.H., a Company organised under the Laws of Germany, of Mullerstrasse, 9, 415 Krefeld-Linn-Rheinhafen, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to refractory nozzles especially for pouring vessels, particularly for the tundish in continuous casting plant, for pouring steel melts, principally aluminium-killed steel melts.

Arrangements for the introduction of a treating gas into the steel melt in a ladle and into the molten metal teeming through the nozzle into a foundry mould or a continuous casting mould are already known in the art. These function, on the one hand, by forcing the gas through a porous brick into the melt in the ladle and teeming the melt through a separate nozzle in the ladle bottom (U.S. Patent Specification No. 2,993,780) and, on the other hand, by forcing the treating gas directly into the nozzle passage in the bottom of the ladle for the purpose of forming a curtain of gas which surrounds the teeming jet of metal (German Petty Patent Specification No. 6,918,019, and unexamined published German Patent Application No. 2,012,691).

Steels cast in continuous casting plant are usually killed to a greater or lesser extent with aluminium, besides other deoxidants. Moreover, an increasing number of steel compositions having higher aluminium contents are now being cast by the continuous casting process. The generation of a simple purging action inside the ladle or tundish by blowing inert gas into the melt for the purpose of refining the same by the precipitation or coagulation particularly of oxide impurities and floating them to the top into the layer of slag is not entirely sufficient for improving the purity of such melts and the formation of deposits constricting the nozzle passage and reducing the pouring rate cannot thereby be avoided.

In order to prevent deposit formation and the undesirable choking of the pouring nozzle it has also been proposed as already mentioned to force the treating gas directly into the nozzle passage to interpose a film of gas between the nozzle wall and the teeming melt. However, even this step is not yet sufficient to prevent oxides from being carried by the metal into the mould where they form occlusions directly underneath the casting surface and thereby considerably impair the quality of the product. It has been found that these oxides which are entrained by the metal jet penetrate far into the molten pool in the mould where fresh oxides may form by secondary deoxidation reactions. Particularly in curved continuous casting plant working at high rates of withdrawal the oxides frequently descend into the converging core of molten metal which is covered by the arch of the frozen shell. Particularly in these zones the oxides rising up the inside of the curve may be intercepted by the roughness of the inside wall and then form cloud-like or highly localised alumina impurities usually containing some silica.

The object of the present invention is to provide a pouring nozzle which firstly enables a very considerable purging action to be achieved by inert treating gas blowing into the ladle or tundish and secondly reduces the formation of deposits in the nozzle passage whilst at the same time decisively lessening the depth of penetration of the teeming jet into the molten pool in the mould.

Thus according to the present invention in a refractory nozzle adapted to provide a pouring outlet to a vessel adapted to contain molten metal for example for a tundish in continuous casting plant, the nozzle defining a duct adapted for the passage therethrough of molten metal the nozzle having an inlet end and an outlet end, the material of the nozzle is gas permeable and has a region of higher gas permeability e.g. being highly permeable to gas adjacent the inlet end and means for supplying gas to both the region of higher gas permeability and the

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region of lower gas permeability of the nozzle. The duct may have an outwardly broadening portion at the inlet end and the region of higher permeability preferably communicates with at least part of this portion of the duct. The means for supplying gas may comprise a chamber e.g. an annular chamber communicating directly with the region of higher gas permeability. The region of higher gas permeability may be provided by an outer refractory portion surrounding an inner refractory portion.

The inner portion may define the outlet duct or substantially all of it apart from a portion of the broadened inlet end.

The inner portion of the nozzle may project from the bottom end of the outer portion of the nozzle and form a neck to which the annular chamber and a refractory mouthpiece can be attached. The projecting end end of the neck is preferably provided with connecting means e.g. external screw threads which co-operate with corresponding connecting means e.g. internal screw threads on the annular chamber and to which the mouthpiece can then be connected e.g. by being screwed on.

In a nozzle constructed as proposed by the present invention the treating gas which ascends a path annularly surrounding the inner part of the nozzle containing the nozzle passage and enters the molten steel in the ladle or tundish firstly causes coarse occlusions to be precipitated before they enter the nozzle passage and secondly coagulates oxide particles of a non-precipitable size so that these are removed by floating up into the layer of slag. At the same time some of the treating gas is driven through the pores of the inner part of the nozzle to enter the nozzle passage partly by the controllable pressure at which this gas is supplied and partly as a result of the vacuum pressure generated by the relatively high velocity flow of the metal through the nozzle. A film of gas is thus formed between the metal jet and the walls of the nozzle passage and this film prevents the formation of deposits of say Al_2O_3 that are likely to form on the nozzle wall, particularly when casting heats high in aluminium. Consequently constancy of the pouring rate can be achieved. On the other hand, the entire jet of teeming metal is permeated by the treating gas, causing turbulence to be subdued and the velocity of flow into the mould reduced to a point at which the depth of penetration of the jet is a minimum. Any impurities that may still remain are not therefore likely to attach themselves to the inside of the frozen shell of the casting, instead of which by virtue of the buoyancy they will rise into the flux powder, and permit a casting of unexceptionable quality to be obtained.

The invention can be put into practice in various ways and a specific embodiment will be described by way of example with reference to the drawing which is a vertical cross-section of a nozzle in accordance with the invention.

The pouring nozzle consists of an inner part 1 embraced by an outer part 2. The refractory material of the outer part 2 consists of a highly gas-permeable material, whereas the inner part consists of a material that is less permeable to gas. The inner part 1 contains the nozzle passage 3. The outer part 2 is externally tapered and inserted from below into the correspondingly shaped nozzle brick 4 in the bottom of a casting ladle 5. The inner part 1 has a neck portion 6 which projects from the bottom end of the outer part 2. The projecting end of this neck is provided externally with screw threads 7 which permit a metal annular chamber 8 to be screwed to the neck. For admitting the treating gas into the interior 9 of the annular chamber 8 the latter is provided with a supply pipe 10. Gas from the annular chamber 8 can enter both the gas-permeable inner part 1 and the gas-permeable outer part 2. Screwed to the extreme bottom end of the neck 6 is a mouthpiece 11.

WHAT WE CLAIM IS:—

1. A refractory nozzle adapted to provide a pouring outlet to a vessel adapted to contain molten metal the nozzle defining a duct adapted for the passage therethrough of molten metal the nozzle having an inlet end and an outlet end, the material of the nozzle being gas permeable and having a region of higher gas permeability adjacent the inlet end and means for supplying gas to both the region of higher gas permeability and the region of lower gas permeability of the nozzle.

2. A refractory nozzle as claimed in Claim 1 in which the duct has an outwardly broadening portion at the inlet end and the region of higher permeability communicates with at least part of this portion of the duct.

3. A refractory nozzle as claimed in Claim 1 or Claim 2 in which the means for supplying gas comprises a chamber communicating directly with the region of higher gas permeability.

4. A refractory nozzle as claimed in any one of Claims 1 to 3 in which the region of higher gas permeability is provided by an outer refractory portion surrounding an inner refractory portion.

5. A refractory nozzle as claimed in Claim 4 in which the inner refractory portion defines the outlet duct or substantially all of it apart from a portion of the broadened inlet end.

6. A refractory nozzle as claimed in any of the preceding claims in which the region of higher gas permeability is highly permeable to gas.

7. A refractory nozzle as claimed in any one of Claims 4 to 6 in which the means for supplying the treating gas comprises an annular chamber which communicates with the outer and the inner portions of the nozzle.

8. A refractory nozzle as claimed in Claim 7 in which the inner portion projects from the bottom end of the outer portion of the nozzle and forms a neck to which the annular chamber and a refractory mouthpiece can be attached.

9. A refractory nozzle as claimed in Claim 7 or Claim 8 in which the projecting end of the neck is provided with connecting means which cooperate with corresponding connecting means on the annular chamber and to which the mouthpiece can then be connected.

10. A refractory nozzle as claimed in Claim 1 and substantially as specifically described herein with reference to the accompanying drawings.

11. A metallurgical vessel whenever provided with a nozzle as claimed in any one of Claims 1 to 10.

KILBURN & STRODE,
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1368390 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*